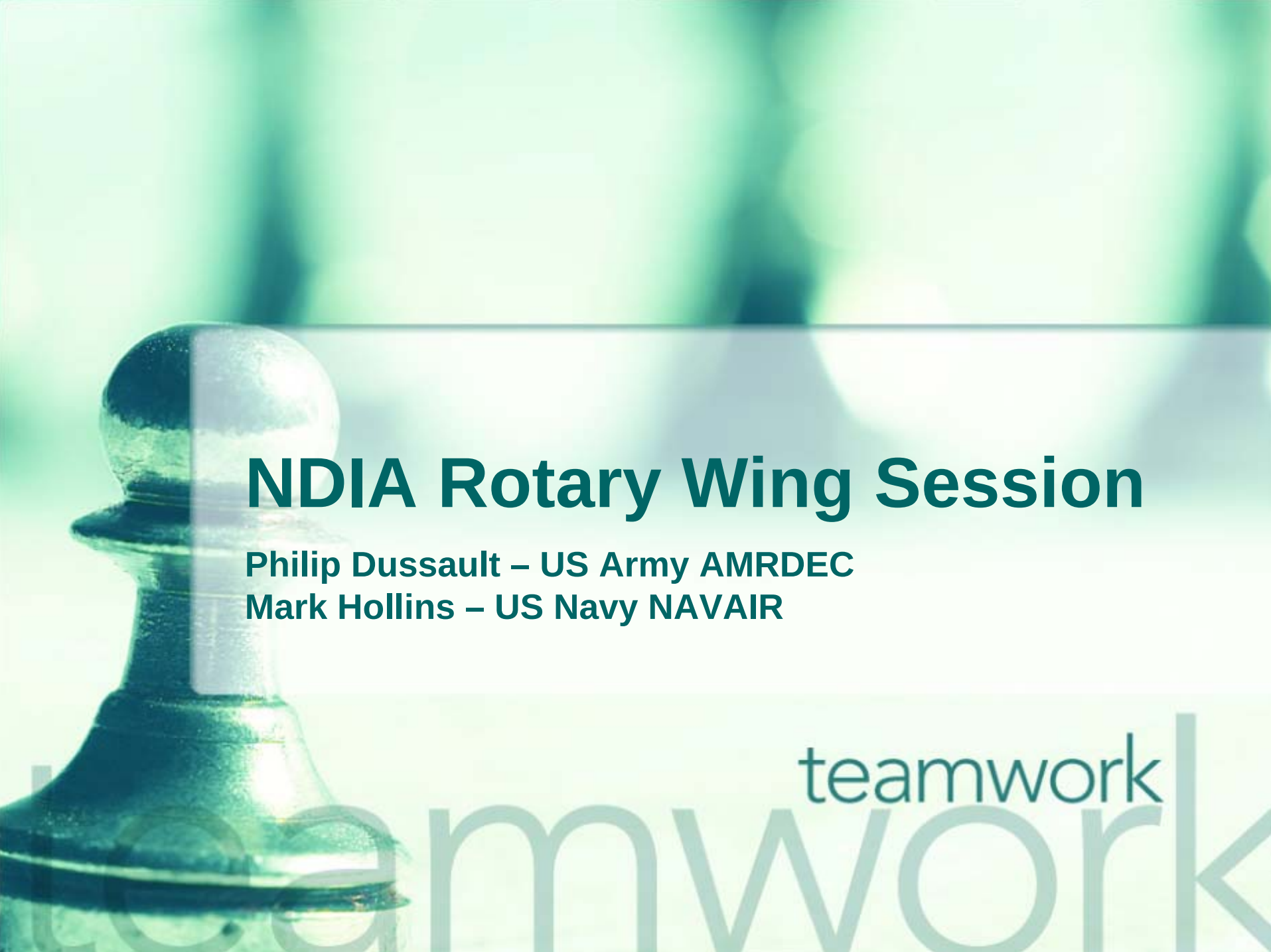


# NDIA Rotary Wing Session

**Philip Dussault – US Army AMRDEC**
**Mark Hollins – US Navy NAVAIR**

# Agenda

- Introductions
- Objectives
  - Definition of equipment types and components that could benefit from prognostics
  - Prognostics lead time needed and confidence level of prediction
  - Technology needs and dates they are required to have greatest system benefit
  - Current R&D you are aware of including details on program and TRL level of technology
  - Identify needs which are not met by current programs
  - Efforts required to develop prognostics technologies
    - Milestone dates
    - Product of R&D efforts
    - Level of effort required
- Templates
  - Consolidate Objectives to Template
  - Report results of session to other attendees

# Key Information to be developed for the workshop

- **Succinct definition of Prognostics Needs for Army Aviation & Missile Systems**
  - Definition of equipment and components that are problematic
    - Avionic/Electronic systems
      - Analog, Digital, Electro-Optics, Power, RF
    - Constitute the following systems:
      - Weapons System
      - Armament System
      - Communications
      - Control/Displays
      - Data Management
      - Fuel Systems
      - Lighting Systems
      - Power Systems
      - Flight Control
      - Guidance/Navigation System
      - RADAR/LADAR/LIDAR
      - Propulsion System
      - Sighting System

# Key Information to be developed for the workshop

- Lead time needed and confidence level needed for prognostics predictions to be useful in an operational system based upon criticality or function
  - Safety Critical Item
  - Mission Essential Item
  - High Cost Item
  - High Maintenance Time
- Prediction horizons vary
  - Mission profile, optempo, function criticality, flight time, environment, cycle time
- Example: Sighting component – Laser Target Designator
  - Need 8 hours lead time before failure for mission planning
  - Need 5 - 10 days lead time for logistics cycle time if part not at unit
  - 70% @ 24 hrs before failure
  - 80% @ 8 hrs before failure
- Time frame in which technology is needed to have greatest system benefit
  - Most programs are going through spiral development or block upgrade programs
  - Complex electronic systems are O&S Cost drivers
  - Phased implementation as technology develops

# Current R&D Activities

| PROJECT TITLE | STATUS | DURATION | AMRDEC POC |
|---|---|---|---|
| PROG/DIAG FOR FUTURE FORCE (ATO) | FUNDED | FY 04-08 | STEPHEN MAROTTA, 256-876-9283 |
| NEURAL NETWORK RELIABILITY PROGNOSTICS TOOL (SBIR) | FUNDED | FY02-05 | WYATT SHANKLE, 256-313-6379 |
| UAV DIAGNOSTICS/PROGNOSTICS (SBIR) | FUNDED | FY 05 | WYATT SHANKLE, 256-313-6379 |
| SOLDER INTERCONNECT PREDICTOR | FUNDED | FY 05-06 | WYATT SHANKLE, 256-313-6379 |
| TECH COORD GRP FOR PREDICTIVE MATERIALS AGING AND RELIABILITY | FUNDED | FY 05-09 | WYATT SHANKLE, 256-313-6379 |
| VIRTUAL SENSORS FOR STATE MEASUREMENTS, HEALTH & USAGE MEASUREMENTS, AND LOAD ESTIMATION | FUNDED UNDER SARAP | FY 03-06 | NED CHASE, 757-878-3025 |
| AFFORDABLE HEALTH AND USAGE MONITORING SYSTEM FOR UNMANNED AERIAL VEHICLES | PHASE I FUNDED PHASE II PROPOSED | FY 04-07 | TREVEN BAKER, 757-878-0155 |
| CORROSION AND CORROSIVITY MONITORING SYSTEM | FUNDED | FY 02-05 | TREVEN BAKER, 757-878-0155 |
| INTEGRATED OIL DEBRIS AND CONDITION SENSOR | FUNDED | COMPLETED | TREVEN BAKER, 757-878-0155 |

# Current Unfunded R&D Activities

| PROJECT TITLE | STATUS | DURATION | AMRDEC POC |
|---|---|---|---|
| UAV CBM THRU DIAGNOSTICS AND PROGNOSTICS | UNFUNDED | FY 06-08 | WYATT SHANKLE, 256-313-6379 |
| DIAG/PROG ALGORITHMS FOR ENABLING ELECTRONIC COMPONENT CBM | UNFUNDED | FY06-10 | ROBERT RUSSELL, 256-842-2767 |
| DEMO OF MANPOWER REDUCTION USING CONTINUOUS CBM OF ELECTRICAL AND WIRING SYSTEMS | UNFUNDED | FY 05-06 | WARREN ALFORD, 256-313-6498 |
| EMBEDDED CBM SYS AND DATA-LINK FOR ROTARY WING AIRCRAFT | UNFUNDED | FY 06-07 | WARREN ALFORD, 256-313-6498 |
| PORTABLE ELECTRICAL SYS CBM BASED TROUBLESHOOTING | UNFUNDED | FY 06-07 | WARREN ALFORD, 256-313-6498 |
| EMBEDDED SENSOR TECH FOR ELECTRICAL CONDUCTIVE PATH AND SYSTEMS | UNFUNDED | FY 06-08 | WARREN ALFORD, 256-313-6498 |

# Key Information to be developed for the workshop

- Key technology needs
  - Sensing Technologies (Conventional, Fiber-Optics, Piezoelectric) for embedded monitoring (electronic/signal properties, condition)
  - Actuation Technologies (Electro-Rheological Fluids, Shape-Memory Alloys, Piezoelectric Materials)
- Efforts required to develop the required prognostics technologies including milestone dates, products of R&D efforts, and level of effort required.
  - Fault Classification Tools
    - Stochastic Modeling Techniques
    - Adaptive Wavelet Based Neural Networks
    - Bayesian Belief Networks
    - Physics of Failure Based Models
    - Reasoning Tools
  - Prognostic Engine
    - Virtual Sensor / Wavelet Neural Network
    - Dynamic Wavelet Neural Network
    - Confidence/Certainty Prediction Tools
  - Validation Methodologies
    - UID LRUs/SRUs
    - Automated functional test programs

# Key Information to be developed for the workshop

- Identification of key programs that can benefit from prognostics
  - System development programs
  - Existing Systems
  - Systems with planned upgrades
- Identification of key contacts in programs that are:
  - Willing to assist in collecting information needed for roadmap development
  - Available to present needs and participate in workshop

| | |
|---|---|
| Weapon System(s) and Application | Rotary Wing Aircraft<br>Electro-Optical Systems, Computers/Processors, Displays, RADAR ,Flight Controls, FADEC, Electro-mechanical Interface, Power Supplies/Power Source, Wiring/Interconnect |
| E-Prog Need Details | ▪ 24 hours / 95% confidence |
| Development Program Elements | ▪ S&T – sensing/detection techniques<br>  ▪ External/integrated stimulus/testing<br>  ▪ physics of failure models<br>  ▪ Prognostics algorithms/reasoning<br>▪ RDT&E – demonstration on military system<br>▪ V&V – Field Testing and Evaluation |
| Current S&T and RDT&E Applicability | ▪ reasoning models<br>▪ Data capture |
| S&T and RDT&E Needs and Development Program Timelines | ▪ yesterday!<br>▪ Development Program Through V&V 4 years |